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Quality Assurance / Quality Control Documentation

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REVIEWERS

A sincere thank you to the following people who reviewed and provided comments during the initial creation of this document:

DISTRIBUTION LIST

The following individuals (or current position holder) will receive a copy of this QAPP , along with any subsequent revisions. The QAPP will also be available online and is recommended reading for all personnel with the WMP and its partners who collect, handle, or analyze water quality and environmental data.

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ACRONYMS AND ABBREVIATIONS

| | |
|-------|--|
| DC | Division of Chemistry |
| DEQ | North Dakota Department of Environmental Quality |
| DI | Analyte Free Deionized Water |
| DM | Division of Microbiology |
| DMP | Designated Project Manager |
| DQI | Data Quality Indicator |
| DQO | Data Quality Objective |
| DWQ | Division of Water Quality |
| EDAS | Ecological Data Application System |
| EHS | Environmental Health Section |
| EPA | United States Environmental Protection Agency |
| IDL | Instrument Detection Limit |
| LIMS | Laboratory Information Management System |
| MDL | Method Detection Limit |
| NDAWN | North Dakota Agricultural Weather Network |
| NDDoH | North Dakota Department of Health |
| NPS | Nonpoint Source Pollution |
| PI | Principal Investigator |
| QA | Quality Assurance |
| QAC | Quality Assurance Coordinator |
| QAM | Quality Assurance Manager |
| QAPP | Quality Assurance Program Plan |
| QC | Quality Control |
| QMP | Quality Management Plan |
| RL | Reporting Limit |
| SAP | Sampling and Analysis Plan |
| SID | Sample Identification Database |
| SOP | Standard Operating Procedure |
| SRM | Standard Reference Material |
| TMDL | Total Maximum Daily Load |
| USGS | United States Geological Survey |
| VOC | Volatile Organic Compound |
| WMP | Watershed Management Program |

INTRODUCTION AND SCOPE

A goal of the North Dakota Department of Environmental Quality (DEQ) is to ensure that all environmental projects produce data that are of known quality and that the data/results are of the quality needed and expected for their intended uses. The US Environmental Protection Agency (EPA) also requires all agencies whose monitoring and measurement efforts are supported or mandated through contracts, grants, regulations or other formalized agreements with the EPA to participate in a centrally managed quality assurance program. To meet this goal and requirement, the DEQ has documented its quality system in a Quality Management Plan (QMP) (NDDoH, 2016). Under the QMP, approval of all quality assurance program/project plans developed by the each of the EHS's programs are delegated to the Designated Project Manager (DPM) assigned to the project by the program manager.

This QAPP is meant to be an umbrella document outlining the minimum QA/QC requirements for all water quality and watershed assessment projects, Section 319 implementation projects and TMDL studies developed and implemented by the WMP and its partners. Due to the various and diverse water quality monitoring projects/studies which are developed and implemented by the WMP, specific details for each project/study will be outlined and described in individual project/study-specific sampling and analysis plans (SAPs) rather than in a specific QAPP for each project/study. SAPs will be prepared before monitoring begins and may be revised at any time during the life of the project/study.

Project/study-specific SAPs must align with this QAPP and should address the key elements of EPA's Guidance for Quality Assurance Project Plans, EPA QA/G-5 (USEPA, 2002) which are not covered by this QAPP. A project/study-specific SAP should address specific project elements such as the purpose of the project/study, data quality objectives (DQOs) and measurement criteria for the project/study, location(s) of sampling sites, sample parameters and sample frequency, sampling methods, analytical methods, sample handling and chain of custody procedures, and any project/study-specific QA requirements that differ from those described in this QAPP, such as the type and frequency of quality control samples, assessment and review procedures, record keeping, data handling and storage, and project personnel roles and responsibilities.

SAPs will reference detailed standard operating procedures (SOPs). The WMP generates SOPs for any sample collection/processing, sample handling, or data management procedure that becomes routine, even when published methods are available. The use of SOPs ensures data comparability, defensibility, accuracy, and reduced bias. Project/study-specific SAPs will be developed by the DPM and reviewed by the WMP Program Manager and designated DWQ Quality Assurance Manager (QAM).

A. PROGRAM MANAGEMENT

A.1 Title and Approval Sheet

See cover page.

A.2 Table of Contents

See pages iii – iv.

A.3 Distribution List

See page ii.

A.4 Program/Task Organization

Overall organization for the DEQ (formally North Dakota Department of Health [NDDoH] EHS) is detailed in the QMP for the NDDoH EHS (NDDoH, 2016). Within the DEQ there are five divisions, including Air Quality, Municipal Facilities, Waste Management, Water Quality, and Chemistry.

Within the DEQ, the Division of Water Quality (DWQ) is organized in three programs, the North Dakota Permit Discharge Elimination System Program, the Groundwater Quality Management Program, and the Watershed Management Program (WMP). Dave Glatt is Director of the DEQ, Karl Rockeman is the Director of the DWQ, and Aaron Larsen is the Program Manager for the WMP, which is responsible for this QAPP.

A.4.1 Quality Assurance Staff

Dennis Fewless is the Quality Assurance Coordinator (QAC) for DEQ. The QAC is located in the DEQ Director's Office and reports directly to the Director of the DEQ. The DEQ Director's Office (through the QAC) is responsible for oversight of the DEQ's quality system for QA and QC as delineated in the QMP for the DEQ, including maintaining and updating the QMP, storing and managing all QAPPs and other QA documents, and coordinating QA training with EPA. It is the policy of the DEQ that the primary responsibility for QA resides among program staff and DPMs in each program; therefore, each program is responsible for the preparation, implementation, and assessment of its QAPP(s).

A.4.2 Data Collection Activities

Most water quality data which is collected for specific water quality and watershed assessment projects, Section 319 Nonpoint Point Source Pollution (NPS) implementation projects, or TMDL studies is performed by non-WMP cooperators (e.g., soil conservation district watershed coordinators) who are

trained in WMP methods and procedures. WMP personnel who are not the DPM may also perform data collection activities. Core water quality monitoring activities involve the collection habitat, macroinvertebrate, fish, algae, bacteria, and water chemistry samples from rivers, streams, lakes and reservoirs. Each of these activities is performed under specific projects with unique monitoring and DQOs which are detailed in approved SAPs and related SOPs

A.4.3 Laboratory Activities

Any laboratory outside the DEQ which is contracted by the WMP or its cooperators must have a documented QA/QC plan and SOPs approved by the WMP to ensure support and adherence to the WMP's DQOs. This documentation will be kept on file by the WMP Program Manager and laboratories will be contacted by the WMP Program Manager each year to inquire if there have been any changes to their QA/QC procedures. In addition, laboratories contract by the WMP or its cooperators must agree to meet any WMP project/study-specific QA/QC requirement not included in the laboratory's QAPP. Further, it is recommended that project/study-specific QA/QC requirements be discussed between the WMP and the laboratory before data collection and analysis begins. For project/study-specific analysis, QA/QC procedures should be documented in the project/study-specific SAP and the appointed DPM should obtain a copy to be provided to the WMP Program Manager and DEQ QAC to be filed with other QA/QC documentation.

Most water samples collected by the WMP and its cooperators are analyzed for chemical constituents by the DEQ Division of Chemistry (DC). The DC maintains its own Quality Assurance Policy (NDDEQ, 2018) which describes QA/QC procedures, analytical methods, and sample handling procedures, including sample bottle and preservation requirements.

All E. coli bacteria samples collected by the WMP and its cooperators are analyzed by the NDDoH Division of Microbiology (DM). The DM maintains its own Quality Assurance Plan (NDDoH, 2019) which describes which describes QA/QC procedures, analytical methods, and sample handling procedures, including sample bottle and preservation requirements for E. coli bacteria.

A.5 Problem Definition/Background

Environmental monitoring data, including water quality monitoring data, can be categorized by the purpose for the monitoring and how the information is assessed and used. The North Dakota Water Quality Monitoring Strategy (NDDoH, 2014) describes four types of monitoring, including: 1) condition monitoring, 2) problem investigation monitoring, 3) effectiveness monitoring and 4) special studies monitoring. While there are similarities among the four monitoring types, these definitions are provided to help distinguish between the

various purposes of monitoring programs and projects necessary to meet the goals and objectives of this strategy.

Condition monitoring is used to identify overall water quality status and trends by assessing the condition of individual waterbodies, populations of waterbodies or watersheds in terms of their ability to meet water quality standards or other established criteria. **Problem investigation monitoring** involves studying specific water quality problems or watershed restoration issues that results in the development of a management or remediation plan to protect or improve the resource. Problem investigation monitoring is used to determine the specific causes and sources of water quality impairments to rivers, streams, lakes, reservoirs or wetlands and to quantify pollutant loads. It is also used to determine the actions that are needed to return a waterbody to a condition that meets standards or other water quality goals. Examples of problem investigation monitoring include TMDL development projects and Section 319 NPS assessment projects. **Effectiveness monitoring** is used to assess the effectiveness and success of specific regulatory or voluntary management actions that have been implemented to improve or protect water quality. Effectiveness monitoring is not only used to evaluate the immediate success of management actions but is used in an adaptive management framework to improve and refine management actions to meet the projects goals. Examples include monitoring associated with TMDL implementation projects or Section 319 NPS watershed restoration projects. **Special studies monitoring** addresses monitoring activities that do not fit neatly into the other three categories. Typically, special studies monitoring would not directly result in an assessment of a specific lake, stream or wetland or in the implementation of management actions for specific waterbodies or watersheds. An example of special studies monitoring would be monitoring to develop numeric nutrient criteria for lakes or streams.

Watershed monitoring projects that address condition assessment, problem investigation and best management practice effectiveness are the primary focus of this QAPP. In addition to TMDL development projects/studies, problem investigation monitoring projects are also described as development phase projects in the North Dakota Nonpoint Source Pollution Management Program Plan (NPS Management Plan) (NDDoH, 2015), while monitoring in support of NPS watershed implementation projects are an example of effectiveness monitoring.

Depending on the type of water quality/watershed monitoring project/study, the specific problem to be solved, decision to be made, or outcome to be achieved should be described in the project/study-specific SAP.

A.6 Project/Task Description

Project/task details are an essential component of project/study-specific SAPs. Each SAP should include a summary of all work to be performed and products to

be produced. In addition, each SAP should include maps and/or tables showing the geographic area that is the focus of the project/study and the location of sampling sites. Each project/study-specific SAP must also include a work schedule indicating start and completion dates for sampling, analysis, data review and analysis, and reporting.

A.7 Quality Objectives and Criteria

Quality objectives are statements of the precision, bias, and laboratory reporting limits (upper or lower) necessary to meet project goals and objectives. Precision and bias together express data accuracy. Other considerations of quality objectives include representativeness, completeness, and comparability.

A.7.1 Data Quality Objectives

Data quality objectives (DQOs) establish acceptable quantitative criteria on the quality and quantity of the data to be collected, relative to the ultimate use of the data and are developed after given careful consideration to the problem, the project/study goal(s), the type of data needed to support project decisions or conclusions, the conditions under which the data should be collected, and the level of uncertainty that decision makers are willing to accept in the collected monitoring data while still meeting the project/study goal(s). The later, establishes the quantity and quality of the data needed for the project/study. The DQOs, also known as performance or acceptance criteria, represent the overarching quality objectives of the study, including that collected data meet defined measurement performance criteria. For most water quality and watershed assessment projects, Section 319 NPS implementation projects, or TMDL studies covered by this QAPP, data will be expected to meet the measurement performance criteria described in Section A.7.2.

A.7.2 Measurement Performance Criteria

Measurement performance criteria are expressed in terms of data quality indicators (DQIs) which include precision, bias, accuracy, representativeness, completeness, comparability, and method sensitivity. Definitions for the following DQIs come from EPA's Guidance for Quality Assurance Project Plans, EPA QA/G-5 (USEPA, 2002). DQIs for projects/studies covered by this QAPP are assessed similarly through quality control samples such as blanks, spikes, and replicates and through data quality checks. The following describes the DQIs and recommended performance goals that will apply to most projects/studies covered by this QAPP. Where the DQIs and performance goals for a specific water quality and watershed assessment project, Section 319 NPS implementation project, or TMDL study deviate from those described below, the revised DQI(s) and performance goal(s) should be described in the project/study-specific SAP.

Precision is the measure of agreement among repeated measurements of the same property under identical, or substantially similar conditions. Overall precision for sampling and analysis is assessed with field duplicate/replicate co-located samples collected, processed, and analyzed to obtain information on sample acquisition, handling, shipping, storage preparation, and analytical processes and measurements. Additionally, laboratories perform their own replicate analysis, initial precision and recovery samples, and matrix spike/matrix spike duplicates to assess laboratory precision. In the field, precision is maximized (variability reduced) through strict adherence to SOPs for sampling methods and sample handling. A precision goal of 20% should be obtained for chemical water quality samples collected for laboratory analysis (e.g., major ions, trace elements, nutrients, total suspended solids, chlorophyll-a) and 40% for *E. coli* bacteria analyzed by the DM. Matrices other than water (e.g., soil, sediment, fish tissues) typically have a higher acceptance limit of 40%. For projects/studies covered under this QAPP precision will be determined through the collection and analysis of field duplicate samples collected with every 10th sample. The equation used for calculating sample precision is given below:

Calculated as Relative Percent Difference (RPD):

$$\text{RPD (\%)} = (A-B)/((A+B)/2) \times 100$$

Where, A = first measured value and B = second measured value.

Bias is the systematic or persistent distortion of a measurement process that causes errors in one direction. Field instruments are calibrated, maintained and checked against standard reference materials (SRMs) to ensure bias is not introduced during measurement of water quality parameters. Bias is also reduced in the field through the use of, and adherence to, SOPs. Field audits of field personnel collecting data are used to qualitatively assess bias. Laboratories test their instruments for bias with reference materials and perform analysis on spiked matrix samples to ensure that instruments/instrument calibration or reagents and matrix effects, respectively, do not introduce bias during analysis. The DC analyzes data from internal standards and keeps logs of control samples to note drift in their instrumentation.

Accuracy is the measure of the overall agreement of a measurement to a known value such as a reference or standard. It includes a combination of random error (precision) and systematic error (bias) components of both sampling and analytical operations. Laboratories test their instruments with reference materials to ensure accurate results (expressed as percent recovery). While the investigator almost never knows the true population values needed to measure precision, bias, and accuracy, field instruments are calibrated, maintained, and checked against standard reference materials (SRMs) to ensure accurate measurement of water quality parameters. In addition, accuracy is improved in the field through the use of and strict adherence to SOPs.

Representativeness is a qualitative term that expresses “the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition” (ANSI/ASQC, 1995). Representativeness is mainly a function of the project/study design. Representativeness is addressed by following SOPs when collecting samples or taking field measurements and through adherence to the sample locations, sampling frequency and times, and hydrologic conditions determined during development of the SAP. Site photos and field notes are also important for describing any unusual conditions at the sampling location (e.g., extreme high or low flow, a contamination event, unusual weather, etc.) that may affect the representativeness of the sample collected during that time. Samples are also evaluated for contamination introduced by the collector or analyzing laboratory through field and equipment blanks. For the chemical analysis of field and equipment blanks the measurement performance criteria are results less than the laboratory’s method detection limit (MDL) for the analyte.

Comparability is a qualitative term that expresses the measure of confidence that one data set can be compared to another and can be combined for the decision(s) to be made. These may be different data sets collected during consecutive years, or data sets collected from different time periods. Data sets are considered comparable when data are collected with the same or equivalent collection and handling methods (i.e., SOPs), sample preparation and analytical procedures, holding times, sample preservation, and QA protocols. Section B.9 of the QAPP discusses the extent to which data from sources outside the WMP (collected by other agencies) are comparable with data collected by the WMP.

Completeness is a measure of the amount of valid data obtained from a monitoring project compared to the amount of valid data expected to be obtained based on the project SAP. Completeness is calculated by dividing the number of valid measurements completed (i.e., samples collected and/or analyzed) by the total number of measurements planned for the project’s dataset and is expressed as a percentage. Completeness is especially important when a certain number of samples are required for assessment purposes (e.g., five E. coli samples per month), to populate a model, or when project funds are limited. For projects/studies covered under this QAPP the completeness goal is 95%. For projects/studies with completeness goals which differ from 95%, the completeness goal(s) should be provided in the project/study-specific SAP.

Sensitivity is a measure of the capability of a field instrument or laboratory method to discriminate between measurement responses representing different levels of the variable of interest, commonly referred to as the detection limit. Sensitivity is determined by the minimum concentration or attribute that can be measured by an instrument (instrument detection limit) or by a laboratory method reported as the MDL and reporting limit (RL).

For measurements taken in the field by an instrument, the instrument detection limit (IDL) is described by its range, accuracy, and resolution. These values are usually reported for each instrument by the manufacturer in the instrument's operating manual.

For the chemical analysis of water quality samples analyzed by the DC laboratory, sensitivity is reported as the MDL and RL. The laboratory MDL for a constituent is the lowest value which can be detected by the instrument, whereas the QL is the lowest value that can be quantified by the analyst and is usually higher than the MDL. Typical MDLs and RLs for chemical constituents analyzed by the DC laboratory are provided in Appendix A. For E. coli samples analyzed by the DM, upper and lower RLs are provided in Appendix B.

IDLs for field measurements and MDLs/RLs for laboratory constituents should be appropriate for the expected range of results and the required sensitivity (detection limit requirements) necessary to meet the data quality objectives described in the project/study SAP. This is especially important for project/studies where field measurements or laboratory results are being compared to numeric water quality criteria for assessment purposes or for TMDL development (see action levels in Appendices A and B). Where practical, laboratories should report any estimated values between the MDL and the RL, as these are more specific/detailed than reporting non-detect below the RL.

A.8 Special training/Certification

A.8.1 General Training

Most of the water quality data collection activities which are performed for specific water quality and watershed assessment projects/studies covered under this QAPP are performed by non-WMP cooperators (e.g., soil conservation district watershed coordinators). In addition, WMP personnel who are not the DPM may also perform data collection activities. Non-WMP cooperators who are responsible for project monitoring activities are referred to as the Principle Investigator (PI). The PI for any water quality and watershed assessment project/study is required to have the necessary knowledge and experience to perform all field sampling activities. Training in the proper methods for sampling include proper use and maintenance of sampling equipment and field instruments, sample processing and handling, field documentation and record keeping, data entry, and file management. Training will be provided to the PI by the DPM with assistance provided by other WMP field staff, if necessary. Prior to training, the PI must read this QAPP, the project/study-specific SAP, and all SOPs he/she will perform and acknowledge that they have done so annually via a signature sheet kept on file at the WMP.

The DPM is responsible for ensuring these general training/certification requirements are satisfied and properly documented each year of the project/study.

A.8.2 Specialized Training

There are many environmental and safety hazards project/study personnel may encounter when working in the field, therefore participation in applicable health and safety training is encouraged by all WMP staff, the PI, and other field personnel assisting with sample collection. Examples of recommended health and safety training are CPR, first aid, defensive driving, watercraft safety, and ice safety. In addition, field personnel should be familiar with safety and traffic control procedures when sampling from bridges.

A.9. Documents and Records

Thorough documentation and management of all field sampling and handling activities is necessary for proper processing in the laboratory, data reduction and, ultimately, for the interpretation of study results. To ensure field and laboratory records are properly documents and data generated are properly stored and managed, the following procedures will be used for all projects/studies covered under this QAPP.

A.9.1 QA Documentation Dissemination and Maintenance

The WMP Program Manager and DWQ QAM are responsible for reviewing and updating this QAPP and all applicable SOPs each year. In addition, all active project/study SAPs are reviewed and updated each year prior to sampling by the DPM. The review and revisions to the QAPP, SOPs, and SAPS will follow document control as described in the NDDoH EHS QMP. Electronic copies of this QAPP, SOPs, and active SAPs will be distributed via email and stored on the DEQ server and posted on the WMP's webpage at [[HYPERLINK "https://deq.nd.gov/WQ/3_Watershed_Mgmt/"](https://deq.nd.gov/WQ/3_Watershed_Mgmt/)]. Additional related QA documents (e.g., field audit reports, QC summaries for datasets, training documentation) will also be stored on the DEQ server.

A.9.2 Field Documentation

The PI will record all field data in a water-resistant field notebook or an equivalent electronic collection platform following the procedures and using forms described in project/study-specific SAPs and associated SOPs. Prior to leaving each site, field staff will check field notebooks or electronic data forms for missing or improbable measurements. In addition, any deviation in an SOP when collecting, processing, or holding samples must be documented and explained in field notes. As soon as practical after returning from the field, the PI will enter field

generated data (paper or electronic) into Microsoft Excel® spreadsheets or a project-specific Microsoft Access® database.

All samples collected for chemical or E. coli analysis and submitted to the DC laboratory will be accompanied by a sample identification/custody form. In addition, a sample identification label will be affixed to each sample bottle submitted to the laboratory. The sample identification/custody form and the sample label will specify the site ID and description, date and time of collection, name of the sampler, and the laboratory analysis requested. Note: When samples are collected from waters known to harbor aquatic nuisance species (e.g., zebra mussels), the sample bottle and sample identification/custody form should be clearly marked "ANS."

Following sample log-in by the DC laboratory, the DC will transmit an electronic copy of the sample identification/custody form, with the laboratory log number, to the WMP Database Manager where it will be entered into the WMP's Sample Identification Database (SID).

A.9.3 Laboratory Documentation

Documentation of laboratory QA/QC procedures and SOPs are beyond scope of this QAPP and are the responsibility of the DC and DM. An electronic copy of the DC and DM Quality Assurance Plans, including any updates, are provided to the WMP Program Manager and the DWQ QAM.

A.9.4 Record Storage and Retention

All data entered into Excel spreadsheets or Access databases by the PI are transferred to the WMP DPM where the data are reviewed for errors and omissions and then stored permanently in a project/study-specific file folder on the DEQ server. All chemical and E. coli data generated by the DC and DM laboratories are transferred electronically to the WMP from the DC Laboratory Information Management System (LIMS) once per week. These raw data along with data from the sample identification/custody forms, site information, and project information are stored permanently on the DEQ server in the WMP Sample Identification Database (SID). A hardcopy of the DC laboratory analysis report is stored permanently by the DC. All data which are stored in SID are also transferred and stored permanently in EPA's STORET/WQX database.

B. DATA GENERATION AND ACQUISITION

B.1 Sampling Process Design

Sampling process design is developed as part of the initial project planning and DQO process and is described in detail in each project/study-specific SAP. The

project/study-specific SAP should address, as appropriate, the following elements of the sampling process design:

- A description of the project monitoring goal(s) and objective(s) (What is the rationale for the project/study and/or which is the question(s) to be answered by the project/study?);
- The project/study area and/or target population;
- The design of the sampling network, including a description and maps showing sampling locations;
- The types and frequency of samples required, including quality control samples;
- Water quality parameters of concern and laboratory analysis requested;
- A description of representative sampling conditions and instructions for field personnel if they encounter non-representative conditions;

B.2 Sampling Methods

Sampling methods are the procedures for collecting samples or taking field measurements and identify the methods and equipment used, including any implementation procedures, sample preservation requirements, decontamination procedures, and materials needed for sampling. The use of standardized sampling methods and trained personnel helps ensure that samples are collected consistently both between sampling locations and sampling personnel. All projects/studies covered under this QAPP, must include a description of the sampling and field measurement methods in the project/study SAP. In cases where the project/study employs a unique or infrequently used sampling or field measurement method, the method must be described in detail in the SAP. However, for sampling and field measurement methods which are used routinely by the WMP, a SOP may be referenced and used in the SAP. SOPs referenced in the project/study SAP should also be included as appendices to the SAP.

SOPs for routine methods may be written by any WMP staff member and must be approved by the DWQ QAM and WMP Program Manager. In general, SOPs should be written in accordance with EPA's Guidance for Preparing Standard Operating Procedures (SOPs) (USEPA, 2007). SOPs developed by the WMP are available on the DEQ server and on the WMP website and should be reviewed annually by WMP staff and the WMP Program Manager.

B.3 Sample Handling and Custody

Sample handling requirements, including bottle type, sample label, preservation and storage, holding times, and delivery to the laboratory or shipping instructions are discussed in detail in each WMP SOP. For unique or infrequently used sampling and analysis methods not described by an SOP, the project/study SAP

should describe the sample handling and custody requirements referenced above.

Each sample that is collected and submitted to a laboratory for analysis is associated with a site identification number. This unique site identifier (historically, a STORET ID) is typically composed of a six-digit number starting with 38XXXX. In addition to the site identification number, samples are also labeled with a site description, the analysis requested, sample preservation method, date and time of collection, project description, and the sampler's name.

Each sample or set of samples delivered or shipped to the laboratory must be accompanied by sample tracking documentation. For routine samples covered under this QAPP and which do not require legal chain-of-custody (CoC), a sample identification/custody form is submitted with each sample or set of samples (Appendix C).

B.4 Analytical Methods

All routine chemical and E. coli sample analysis covered by this QAPP will be performed by the DC and DM laboratories, respectively, and will follow approved and published methods (Appendices A and B). When a project/study requires a contract laboratory for chemical analysis, the project/study-specific SAP must describe the analytical method and detection limits to be used for the project/study. SAPs should also include needed laboratory turnaround times and it is recommended that turnaround times are discussed with the contract laboratory prior to the start of sample collection. When analytical failures occur, whether recognized by the DPM or by the PI, the WMP Program Manager will be notified to begin a dialog with the analyzing laboratory to remedy the error/issue. In addition, any issues with analytical data will be communicated to the WMP Database Manager so that he is able to isolate the potentially problematic data before it is uploaded to the WMP water quality database (SID).

B.5 Quality Control

Implementing QC procedures provides the information needed to assess the quality of the data that is collected. These procedures also help identify problems or issues associated with data collection or analysis while the project is underway.

B.5.1 Field Quality Control Activities

Field QC checks and samples will be performed at a frequency defined by the DPM in the project/study-specific SAP. Each project/study-specific SAP should list each required QC check or sample, the associated performance goal, and corrective actions in case that performance goal is not met.

B.5.2 Field Quality Control Samples

Quality control samples are used to estimate the precision, representativeness, and accuracy/bias of field activities or field plus laboratory activities. Where practical, the following are the types of quality control samples that should be collected with every project/study covered by this QAPP. Field quality control samples should be prepared in accordance with WMP SOPs, and labeled, documented, handled, and analyzed the same as regular samples. Field and/or equipment blank samples are primarily applied to chemistry samples and are inappropriate or unnecessary for E. coli, total suspended solids, or for biological samples.

- One **equipment blank** per 10 samples collected, or one per sampling trip if less than 10 samples are collected. Analyte-free deionized (DI) water must be run through each piece of sampling and/or sample-processing equipment, collected in appropriate sample bottles, and analyzed for the same constituents as the regular samples planned for that trip. If equipment is prepared by field staff and used for multiple samples (therefore not decontaminated between samples), the equipment blank should be performed before the first sample is collected to confirm that the equipment was properly cleaned/prepped prior to sampling. If sampling equipment is decontaminated in the field between samples, the equipment blank should be performed after decontamination and before the next sample is collected to confirm that the equipment was properly cleaned between samples. If no sampling equipment or sample processing is performed, no equipment blanks are required. For example, grab sampling for non-filtered constituents requires no equipment blank.

- Performance Goal: below detection limit or “non-detect”

- One **trip blank** (also known as a travel blank) per cooler containing volatiles when collecting volatile organic compound (VOC) samples. Trip blanks are prepared by the laboratory using DI water, transported to the field, and handled in the same manner as other samples; they are not to be opened in the field.

- Performance Goal: below detection limit or “non-detect”

- One **field blank** per trip (sampling event) per sampling crew per each sample type collected, as appropriate. Field blanks are used to assess potential sample contamination due to sample bottles, preservative, ambient site conditions, or cross-contamination during transport. Sample bottles should be filled at a sampling location defined in the SAP with DI water, and handled in the same manner as other samples. Bottles containing preservative are not to

be rinsed. Unpreserved bottles should be triple-rinsed with DI water before filling, as is done for regular samples.

- Performance Goal: below detection limit or “non-detect”

- One **duplicate/replicate** sample per 10 samples (10%) collected for a particular project/study or more frequently depending on project/study-specific goals. The sampling conditions, volume of sample needed, and whether or not a sampling device is used will determine whether sample pairs are duplicates (homogenized and split into bottle pairs) or replicates (not homogenized, collocated samples) and should be defined in the project/study-specific SAP.

- Performance Goal: < 20% RPD for chemical analysis of water; <40% for E. coli analysis and other non-water matrices

There are other optional field quality control samples such as field split samples to assess accuracy and comparability of results between two analytical methods or laboratories and field matrix spikes to determine the effect of the sample preservation, shipment, storage, and preparation on analyte recovery efficiency for a given matrix. Project/study-specific SAPs may specify a higher frequency of quality control sample collection than listed above. When planning QC sample type, frequency, and collection locations, DPMs should consider performing additional equipment blanks if a “dirty” site must be sampled in the middle of a trip (ideally less contaminated sites are sampled before more contaminated sites during a trip) or targeting contaminated sites for duplicate/replicate and field split samples to evaluate the effect of challenging matrices on target analyte recovery.

B.5.2.1 Field QC Checks

Field-based QC checks should include at a minimum:

- Daily calibration of water quality field meters and post-calibration checks using unexpired and certified calibration standards or standard reference materials (SRMs).

- Performance Goal: 100% compliance and completed documentation, SOPs followed

- Review of field water quality parameters for reasonable values.
- Review of all field documentation for accuracy and completeness before leaving the sampling location. Field sheets for routine monitoring projects should include checklists to ensure all samples are collected and all field measurements are performed.

- Repeat calibration and documentation in the event of a violation of a water quality standard based on numeric criteria (dissolved oxygen < 5 mg/L).

B.5.2.2 Corrective Actions

Specific corrective actions for failure to meet performance goals for field QC activities should be described in each project/study-specific SAP. Field personnel are responsible for performing immediate corrective action in the field if a QC issue is found during field QC checks; typically, this corrective action will involve instrument maintenance or recalibration. Field personnel will document this type of corrective action in the field notes. Other corrective actions are the responsibility of the DPM and, when they involve WMP staff, the WMP Program Manager. Each failure must be investigated and addressed for the cause of non-compliance if possible (for example, decontamination procedures, inadequate training of staff, improper sample handling). The DPM must address the quality control issue and any actions taken to resolve the matter (retraining of field staff, purchase of new reagent/bottles, replacement of equipment, etc.) should be documented in the project files. The DPM may perform resampling and analysis, revising sampling and/or analysis procedures, or may accept the data with acknowledgment of the level of uncertainty surrounding the analytical results. The WMP Program Manager will be notified for any systemic problems unable to be addressed by the DPM alone.

B.5.3 Laboratory Quality Control Activities

Internal laboratory quality control samples will be performed as defined by the DC's quality assurance manual and corrective actions are the responsibility of the DC.

B.6 Instrument/Equipment Testing, Inspection, and Maintenance

It is the PI's responsibility to test, inspect, and maintain all field instruments and equipment prior to sampling. Field equipment will be inspected and tested prior to sampling activities to ensure that the equipment is functioning properly and to allow time for replacement or repair of identified deficiencies. All field equipment will be maintained according to manufacturer's specifications.

B.7 Instrument/Equipment Calibration and Frequency

The primary instruments requiring calibration for projects/studies covered by this QAPP are stream stage automated recorders and temperature/dissolved oxygen meters. These instruments will be calibrated according to the manufacturer's specifications.

B.8 Inspection/Acceptance of Supplies and Equipment

Careful and thorough planning is necessary to ensure the efficient completion of the field sample collection tasks. A general checklist of field equipment and supplies is provided in the SOPs. It is the responsibility of the PI to gather and inspect the necessary sampling equipment and supplies prior to each sampling trip.

B.9 Non-direct Measurements and Data from External Sources

B.9.1 Non-direct Measurements

Non-direct measurements will include identification and/or verification of each sample location (i.e., latitude and longitude). The latitude and longitude coordinates, in decimal degrees, will be recorded. A hard copy table of the location of each sampling site and a map depicting each location will be included in the project/study-specific SAP.

B.9.2 Data from External Sources

For projects/studies covered by this QAPP the data obtained from secondary (non-WMP) measurement sources include climatological/meteorological, stream discharge, and GIS (geographical information system) data. Secondary data, whether obtained from federal, state, or local governmental agencies, universities, or other entities, must be approved for use by the WMP Program Manager. Secondary data, at a minimum, must have been collected and validated using documented procedures and must include the appropriate metadata so that the WMP DPM may assess its content, characteristics, quality, and condition. For projects/studies utilizing stream discharge data obtained from the United States Geological Survey (USGS), climatological/meteorological data obtained for the North Dakota Agricultural Weather Network (NDAWN), or GIS data obtain from the North Dakota GIS Hub, these data are assumed to be of sufficient quality. For other secondary data obtain for use by a project/study, the project/study-specific SAP should identify these secondary data sources, describe how the data will be used, and discuss the acceptance criteria and any limitations for using such data. The DPM must document (in a SAP or final report) how they determined that a secondary data set was of sufficient quality (Note: It is not enough to assume that a data set is reliable simply because it was collected by a well-known or trusted source.

B.10 Data Management

Each DPM is responsible for making sure data relevant to their project/study have been managed and stored properly. Any data management procedures specific to a monitoring project/study should be described in the project/study-

specific SAP. Once received, data and database management is the responsibility of the WMP Database Manager.

B.10.1 Field Data Management

Field data management is discussed in Section A.9, in individual WMP SOPs, and in project/study-specific SAPs.

B.10.2 Chemistry and E. coli Data Management

Samples collected for chemical and E. coli analysis are documented and tracked through sample identification labels, field and laboratory recording forms and sample identification/custody forms. Water samples are transported or shipped by field personnel to the DC laboratory in Bismarck, ND where they are logged in and entered into the LIMS.

Results of chemical analysis of water samples performed by the DC and E. coli analysis performed by the DM are transmitted by the DC from LIMS to the WMP Database Manager electronically as an ASCII text file. Results transmitted electronically are stored by the WMP in SID, an Access 2016 based data management system. SID also supports EPA's national Water Quality Exchange (WQX) schema, allowing for the weekly submission of water quality data directly to the EPA using a standardized data flow in XML (eXtensible Markup Language).

B.10.3 Biological Data Management

Biological sample results (macroinvertebrates and fish)) and accompanying habitat data are stored electronically in the WMP's Ecological Data Application System (EDAS V 3.3). EDAS is a custom database application that operates in Access 2016. EDAS was developed by Tetra Tech, Inc. under contract to the EPA. All macroinvertebrate samples are processed by the Valley City State University Macroinvertebrate Lab and are received electronically in the form Excel spreadsheets and are entered into EDAS by the WMP Database Manager. Fish and habitat data collected by the WMP are hand entered into EDAS from field forms by WMP staff.

C. ASSESSMENT AND OVERSIGHT

This section of the QAPP addresses assessments or evaluations to occur both during and after data collection in order to determine whether the project/study-specific SAP is being implemented as approved.

C.1 Assessments and Response Actions

DPMs are responsible for assessing the quality of the work done for their project/study. Assessment activities may be initiated by DPMs or the WMP Program Manager. Examples of assessment activities that may be performed for projects/studies covered by this QAPP include independent assessments of field activities conducted by a third party, internal WMP field audits, or data validation of selected data sets by WMP staff. Each project/study-specific SAP shall include a list and schedule for assessment activities to be conducted during that project/study and identify the individuals to be involved. In addition, any DWQ QAM or the WMP Program Manager may initiate an assessment activity at any time throughout the course of a project/study. Any improvement needs will be addressed at the field staff level with the DPM. Issues that cannot be resolved at this level shall be brought to the attention of the WMP Program Manager. Changes will be made to environmental data collection operations to improve quality. These corrective actions will be documented and kept in project/study files by the DPM or if systematic changes are made, they will be documented and kept on file by the WMP Program Manager.

Failures in the chemical analysis system (e.g., performance requirements are not met) and corrective actions for those failures are beyond the scope of this QAPP.

C.1.1 Field Assessments

Field audits will be performed as often as is appropriate and practical during field sampling, at a frequency defined by a DPM in a project/study-specific SAP or as initiated by the WMP Program Manager. At a minimum, a field audit of field sampling activities will be conducted at least once during the project/study. This audit should be conducted early during the project/study field season in case any problems are identified they can be corrected quickly to minimize the possibility of compromising data. Field audit techniques include checks on sampling equipment and the review of sampling methods.

Each project/study-specific SAP should list each required field assessment activity, the associated acceptance criteria (performance goal), and corrective actions if acceptance criteria is not met. If field audits reveal systemic field data quality issues, the DPM will notify the WMP Program Manager. Results of field audits will be documented and maintained by the DPM in project files.

Field data is assessed continuously by field personnel, in the field and back in the office. If temperature, dissolved oxygen (DO) or pH readings are found to be illogical (based on best judgment) or exceeding water quality numeric criteria for the site being sampled, staff will check or recalibrate the field instrument to be certain of the values measured. Recalibration guidelines may depend on the instrument being used and the best judgment of the field personnel. Upon

returning from the field, field personnel review their field data and sample collection completion using checklists.

C.1.2 Laboratory Audits

Internal and external laboratory audits will be performed as defined by the DC's and DM's quality assurance manuals and are the responsibility of each laboratory. Results of these audits are kept on file by each laboratory, but may be requested by a DPM as part of the project/study-specific SAP. Audits relating to project/study-specific performance criteria should be discussed with the laboratory during project planning stages, if possible. In addition, the WMP may also submit Performance Evaluation samples which are commercially purchased target analytes at known concentrations submitted "blind" by the WMP to the laboratory for analysis.

The DC laboratory is audited by EPA triennially and the audit report can be requested by the WMP. The USGS also sends the DC laboratory proficiency test samples quarterly or annually and the results are shared with the WMP.

The DM laboratory is audited by EPA Region 8 triennially. The laboratory also purchases proficiency tests from an accredited provider annually.

At the start of a monitoring project, the DPM should discuss laboratory audits and laboratory SOPs with the laboratory, especially for laboratories performing new or non-EPA approved methods. Decisions regarding non-traditional analyses should be documented in the SAP or a final report and it should be noted whether a laboratory was or was not willing to grant the WMP the opportunity to perform an audit.

C.1.3 Record Checks

At a minimum, record checks will be performed by the DPM on annual basis during the field audit or at the end of each field sampling season, if no field audit is conducted. Record checks will be performed at a frequency defined by the DPM in the project/study-specific SAP. The project/study-specific SAP should list each required record checking activity (e.g. completeness of field forms and field notes), the associated acceptance criteria (performance goal), and corrective actions if acceptance criteria is not met. If record checks reveal systemic data management issues, the WMP Program Manager will be notified.

C.2 Reports to Management

The project/study-specific SAP should identify the authorship, recipient, contents, frequency, and distribution of reports issued to inform management of project

status and QA issues. At a minimum, problems and corrective actions identified by the PI will be reported to the DPM each week during the field season. Significant problems identified by the PI, as well as problems and corrective actions identified by the DPM during the field audit and record checks, will be reported to the WMP Program Manager, as needed, or as part of annual reports.

D. DATA VALIDATION AND USABILITY

The final section of this QAPP addresses the final project/study checks to determine if the data obtained will conform to the project's/study's objectives (DQOs), and to estimate the effect of any deviations. The status of all data collected for the project/study is considered "Preliminary" until it has been reviewed by the DPM and accepted, validated, and finalized or rejected. These review statuses will be used to track data through the QA/QC process. No datasets will be made "Final" until all expected results are received and validated.

D.1 Data Review, Verification, and Validation

The level of detail and frequency for performing data review, verification, and validation activities will depend on the complexity of the project/study and the importance of the decision to be made based on the data. Data review and validation provide a method for determining the usability and limitations of data, and provide a standardized data quality assessment. The following are the minimum data review, verification, and validation methods to be used for projects/studies covered by this QAPP. For projects/studies which require more or less stringent data review, verification, and validation methods, these methods should be described in the project/study-specific SAP.

D.1.1 Data Review

Data review, as defined by EPA, is the in-house examination to ensure that data have been recorded, transmitted, and processed correctly and includes the following activities: checking for data entry, transcription, calculation and reduction, and transformation errors. Activities also include generating a list of all samples collected (regular samples, blanks, duplicates) as well as the sample information (shipping dates, verification of sample receipt, verification that proper preservatives were used and holding times were met) to ensure that the samples/parameters planned are the same number and type as those actually collected. Data review will occur on a frequent basis for ongoing data collection activities or may only occur a few times during a shorter data collection project. The DPM is ultimately responsible for ensuring that all data are reviewed, but the data review tasks can be assigned to the PI or other field personnel

D.1.1.1 Field Data Review

The PI and DPM will work together to review and verify the quality of field data (electronic and hard copy). Field data for the entire sampling trip will be reviewed by the PI or other field staff both during and after the trip. This review must be completed within 2 weeks of trip completion and includes the following: checking field documentation and electronic field data for data entry, transcription, calculation and reduction, and transformation errors as well as completeness, proper format, and initial filing into the proper location. The field personnel performing this task should sign/initial any hard copy field forms/notes that they have reviewed. Following the initial review of the data by field personnel, the DPM will perform a secondary check of the above-listed items, follow up on questionable data points, sign/initial the hard copy field data, and file it in the project folder. The DPM should review field data (hard copy and electronic) quarterly at a minimum.

D.1.1.2 Laboratory Data Review

The submission of samples to the DC laboratory includes a sample identification/custody form documenting the site location, analysis requested, sample date and time, and name of the person(s) collecting the samples. Upon receipt of the sample(s), laboratory login personnel checks to ensure that holding times have not been exceeded and that the samples were properly preserved. The laboratory will report violations of holding times and/or improperly preserved samples to the DPM or WMP Program Manager. The DPM or WMP Program Manager, in consultation with laboratory personnel, will determine whether or not to proceed with the analysis of that sample and/or analyte.

Following analysis, laboratory results are initially reviewed and reported by the DC laboratory analyst and approved by the DC Director. The reviewed and approved data package is then submitted by the laboratory to the WMP Database Manager where it is uploaded in the WMP's SID database. The WMP Database Manager also conducts a review of the laboratory data. After the data are uploaded to SID, the database performs some automated checks of the data against thresholds based expected values for data collected from the site, the analyte, unit of measure, and sample fraction. Laboratory results passing this second review are then uploaded for permanent storage in SID. Laboratory results which exceed established thresholds are flagged by the WMP Database Manager and the DPM or WMP Program Manager is notified and additional review is conducted.

D.1.2 Data Verification

Data verification is the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the methods, procedures, or contractual requirements defined for the project/study.

D.1.2.1 Field Data Verification

Field data verification begins in the field with data verification by the PI and should be completed before leaving each site. In-field verification includes checking field notebooks, forms, and electronic information storage devices for missing or improbable measurements. The process for in-field data verification involves checking the data sheet (written or electronic) for omissions or outliers. If measurement data are missing or a measurement is determined to be an outlier, the measurement will be flagged in the data sheet and repeated if possible.

Upon returning from the field, data are either manually entered, if data are recorded on paper forms or a log book, or downloaded from instruments and then uploaded into the appropriate database or project folder. Manually entered data should be verified/checked by a staff member who did not enter the data. Downloaded electronic data files will also be checked for completeness and appropriate metadata (e.g., filename, time code).

Field data verification also occurs concurrently with field audit activities conducted by the DPM. The DPM should ensure that data are being collected according to the appropriate SOP(s). The DPM should also continuously be assessing the completeness, representativeness, and comparability of the dataset during data collection to ensure it conforms to the project/study's performance criteria.

D.1.2.2 Laboratory Data Verification

Some analytical data verification occurs concurrently with laboratory data review as discussed above and is performed by both the laboratory staff and WMP staff. In addition, the DPM should use sample tracking to verify that the laboratory is meeting the performance criteria (e.g., reporting limits) agreed to during project planning stages. Data verification is also supported by laboratory audit activities. Data verification is also discussed with the laboratory on an annual basis, during a DEQ/laboratory coordination meeting each spring. At this time, results of EPA audits can be discussed and any systemic data quality issues can be addressed.

D.1.3 Data Validation

Data validation, as defined by EPA, is an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set. It focuses on the project's/study's specifications or needs, is designed to meet the needs of the decision makers/data users and should note potentially unacceptable departures from the SAP or QAPP. Data validation is primarily the responsibility of the DPM because they are the most familiar with the project/study-specific goals, although some data validation tasks general enough to apply to all monitoring will be performed by the WMP Database Manager and other WMP staff. The minimum performance criteria listed in Sections A.7 and B.5 should generally be met for all monitoring projects/studies covered by this QAPP unless otherwise justified and described in the SAP. The DPM or WMP Database Manager may flag or qualify results or add result comments to data records in the database. Data in the database will never be deleted, although if it does not pass data validation, it will be given a "Rejected" result status. The result status of the data in SID that passes validation will be changed from "Accepted" to "Validated".

The potential effects of any deviation from ideal data quality will be evaluated during the final data quality assessment (see below), but initial data validation should be performed in the earliest stages of a project/study or on an ongoing basis for long-term projects/studies in order for DPMs to perform any necessary corrective actions or adjustments to the project/study-specific SAP before the rest of the dataset is collected. For example, the first batch of analytical data for a project/study should be reviewed by the DPM immediately to determine if detection limits are adequate to perform comparisons to action levels, such as numeric water quality criteria. The quality control samples and activities as prescribed in the SAP should be evaluated by the DPM, with the help of the WMP Database Manager, and should continue to be evaluated on at least a quarterly basis throughout the life of the project. If there are issues, the DPM or WMP Program Manager will follow up with corrective actions as necessary. Blanks will be evaluated immediately after data is received from the laboratory and the results reported by the WMP Database Manager to the DPM and the laboratory personnel so they may follow up with immediate corrective action if needed to address sample contamination issues. The DPM should download the project dataset (both field and lab data) on at least a quarterly basis, perform validation activities, summarize the results in a narrative form to be kept in the project file, and notify the WMP Database Manager when the validation of that dataset is complete. The WMP Database Manager will make any changes to the data that are necessary as a result of the validation.

D.2 Verification and Validation Methods

Most of the routine verification and validation methods which will apply to data collected by projects/studies covered under this QAPP are provided in the previous section D.1. In general, these methods describe how project data will be verified and validated, how any issues found will be resolved and who will resolve them and how the results will be conveyed to the data user(s). Any verification and validation methods to be used other than those mentioned above should be described explicitly in the project/study-specific SAP. If there are specific data verification activities (e.g. outlier analyses) that are described in the final report for a monitoring project/study, those methods must be thoroughly documented in the report to explain any changes that were made to the dataset to enable analysis.

D.3 Reconciliation with Data Quality Objectives and User Requirements

This portion data quality assessment is the culmination of the entire QA process for a monitoring project/study. DQOs for each WMP project/study should be clearly defined and documented. An assessment of the usability and limitations of all data collected and validated, with respect to the original DQOs, must be documented after completion of data collection activities. The DPM is ultimately responsible for performing this final assessment of the data quality but may be assisted by the WMP Database Manager and other WMP or project staff. For routine projects/studies covered by this QAPP, the review, verification, and validation procedures described above will be used to determine if the data collected answers the original questions asked (DQOs). These procedures also describe how issues will be resolved and discuss how limitations on the use of the data will be reported to decision makers. The final data quality assessment should be documented as a standalone report and included in an appendix to the final project/study report.

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Appendix A

Laboratory Methods and Performance Criteria for Analytes Analyzed by the Division of Chemistry

| Analyte | | | | Analytical Method | | Achievable Laboratory Limit | | Action Limit |
|---------------------------------|-------------------|------------|--------------|--|----------|-----------------------------|-----------------|---------------------------|
| Description | Sample Fraction | Lab Number | Group Number | Method | Revision | MDL ¹ | RL ² | |
| Alkalinity (CaCO ₃) | Total | 9325 | 199 | SM 2320-B | 2011 | | 3.3 mg/L | |
| Aluminum (Al) | Total Recoverable | 1113 | 7 | EPA 200.7 | Rev 4.4 | MDLb = 29 ug/L | 50 ug/L | 87 ug/L ⁹ |
| Aluminum (Al) | Dissolved | 1713 | 144 | EPA 200.7 | Rev 4.4 | MDLb = 22 ug/L | 50 ug/L | 87 ug/L ⁹ |
| Ammonia as N | Total | 9085 | 30 | Lachat QuikChem Method No. 10-107-06-5-J | Rev 2.0 | *MDLs = 0.05 mg/L | 0.03 mg/L | 0.18 mg/L ^{9,10} |
| Ammonia as N | Dissolved | 9086 | 160 | Lachat QuikChem Method No. 10-107-06-5-J | Rev 2.0 | *MDLb = 0.06 mg/L | 0.03 mg/L | 0.18 mg/L ^{9,10} |
| Antimony (Sb) | Total Recoverable | 2151 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.27 ug/L | 1 ug/L | 5.6 ug/L ^{3,7} |
| Antimony (Sb) | Dissolved | 2751 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.38 ug/L | 1 ug/L | 5.6 ug/L ^{3,7} |
| Arsenic (As) | Total Recoverable | 2133 | 7 | EPA 200.8 | Rev 5.4 | MDLs = 0.12 ug/L | 1 ug/L | 10 ug/L ^{3,7} |
| Arsenic (As) | Dissolved | 2733 | 144 | EPA 200.8 | Rev 5.4 | MDLs = 0.19 ug/L | 1 ug/L | 10 ug/L ^{3,7} |
| Barium (Ba) | Total Recoverable | 2156 | 199 | EPA 200.8 | Rev 5.4 | MDLs = 0.34 ug/L | 1 ug/L | 1.0 mg/L ⁴ |
| Barium (Ba) | Dissolved | 2756 | 173 | EPA 200.8 | Rev 5.4 | MDLb = 0.19 ug/L | 1 ug/L | 1.0 mg/L ⁴ |
| Beryllium (Be) | Total Recoverable | 2104 | 7 | EPA 200.8 | Rev 5.4 | MDLs = 0.27 ug/L | 1 ug/L | 4 ug/L ^{3,7} |
| Beryllium (Be) | Dissolved | 2704 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.17 ug/L | 1 ug/L | 4 ug/L ^{3,7} |
| Bicarbonate (HCO ₃) | Total | 9315 | 199 | SM 2320-B | 2011 | | 4 mg/L | |
| Boron (B) | Total Recoverable | 1105 | 7 | EPA 200.7 | Rev 4.4 | MDLs = 39.4 ug/L | 50 ug/L | 0.75 mg/L ⁵ |
| Boron (B) | Dissolved | 1705 | 144 | EPA 200.7 | Rev 4.4 | MDLs = 45 ug/L | 50 ug/L | 0.75 mg/L ⁵ |
| Bromide (Br) | Total | 9455 | 9455 | EPA 300.0 | Rev. 2.1 | MDLb = 0.02 mg/L | 0.05 mg/L | |
| Cadmium (Cd) | Total Recoverable | 2148 | 7 | EPA 200.8 | Rev 5.4 | MDLs = 0.14 ug/L | 1 ug/L | 0.72 ug/L ^{6,9} |
| Cadmium (Cd) | Dissolved | 2748 | 144 | EPA 200.8 | Rev 5.4 | MDLs = 0.19 ug/L | 1 ug/L | 0.72 ug/L ^{6,9} |

| Analyte | | | | Analytical Method | | Achievable Laboratory Limit | | Action Limit |
|---------------------------|-------------------|------------|--------------|--------------------------------------|----------|-----------------------------|-----------------|---------------------------|
| Description | Sample Fraction | Lab Number | Group Number | Method | Revision | MDL ¹ | RL ² | |
| Calcium (Ca) | Total Recoverable | 1220 | 199 | EPA 200.7 | Rev 4.4 | MDLb = 0.276 mg/L | 2 mg/L | |
| Calcium (Ca) | Dissolved | 1820 | 173 | EPA 200.7 | Rev 4.4 | MDLs = 0.18 mg/L | 2 mg/L | |
| Carbonate (CO3) | Total | 9310 | 199 | SM 2320-B | 2011 | | 1 mg/L | |
| Chemical Oxygen Demand | Total | 9525 | 9525 | Hach 8000 | Rev 1.0 | MDLs = 5.06 mg/L | 5 mg/L | |
| Chloride | Dissolved | 5217 | 199 | EPA 300.0 | Rev 2.1 | MDLb = 0.370 mg/L | 1 mg/L | 100 mg/L ^{3,5} |
| Chlorophyll A | Total | 5118 | 105 | SM 10200-H | 1994 | NA | 1.5 ug/L | |
| Chlorophyll B | Total | 5136 | 105 | SM 10200-H | 1994 | NA | 0.5 ug/L | |
| Chromium (Cr) | Total Recoverable | 2124 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.37 ug/L | 1 ug/L | |
| Chromium (Cr) | Dissolved | 2724 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.31 ug/L | 1 ug/L | |
| Conductivity | Total | 9330 | 199 | SM 2510B | 2011 | NA | NA | |
| Copper (Cu) | Total Recoverable | 2129 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.40 ug/L | 1 ug/L | 9.3 ug/L ^{6,9} |
| Copper (Cu) | Dissolved | 2729 | 144 | EPA 200.8 | Rev 5.4 | MDLs = 0.24 ug/L | 1 ug/L | 9.3 ug/L ^{6,9} |
| Phosphorus as P | Dissolved | 9412 | 160 | Lachat QuikChem Method 10-115-01-1-E | Oct 1994 | (total) MDLb = 0.01 mg/L | 0.02 mg/L | |
| Dissolved Solids(C)-Total | Total | 9935 | 199 | SM 2540 C | 2011 | | NA | |
| Fluoride (F) | Dissolved | 5209 | 173 | EPA 300.0 | Rev 2.1 | MDLb = 0.021 mg/L | 0.05 mg/L | 4,000 ug/L ^{3,7} |
| Hardness Total (as CaCO3) | Total | 9840 | 199 | SM 2340 B calculated | 2011 | NA | NA | 4,000 ug/L ^{3,7} |
| Hydroxide (OH) | Total | 9320 | 199 | SM 2320-B | 2011 | | 1 mg/L | |
| Iron (Fe) | Total Recoverable | 1226 | 7 | EPA 200.7 | Rev 4.4 | MDLb = 0.014 mg/L | 0.05 mg/L | |
| Iron (Fe) | Dissolved | 1826 | 144 | EPA 200.7 | Rev 4.4 | MDLs = 0.016 mg/L | 0.05 mg/L | |
| Lead (Pb) | Total Recoverable | 2182 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.33 ug/L | 1 ug/L | 3.2 ug/L ^{6,9} |
| Lead (Pb) | Dissolved | 2782 | 144 | EPA 200.8 | Rev 5.4 | MDLs = 0.19 ug/L | 1 ug/L | 3.2 ug/L ^{6,9} |
| Magnesium (Mg) | Total Recoverable | 1212 | 199 | EPA 200.7 | Rev 4.4 | MDLs = 0.251 mg/L | 1 mg/L | |

| Analyte | | | | Analytical Method | | Achievable Laboratory Limit | | Action Limit |
|-------------------------------|-------------------|------------|--------------|--|------------------------------|-----------------------------|-----------------|------------------------|
| Description | Sample Fraction | Lab Number | Group Number | Method | Revision | MDL ¹ | RL ² | |
| Magnesium (Mg) | Dissolved | 1812 | 173 | EPA 200.7 | Rev 4.4 | MDLs = 0.314 mg/L | 1 mg/L | |
| Manganese (Mn) | Total Recoverable | 1225 | 7 | EPA 200.7 | Rev 4.4 | MDLb = 0.005 mg/L | 0.01 mg/L | |
| Manganese (Mn) | Dissolved | 1825 | 144 | EPA 200.7 | Rev 4.4 | MDLs = 0.003 mg/L | 0.01 mg/L | |
| Molybdenum (Mo) | Total Recoverable | 2142 | 199 | EPA 200.8 | Rev 5.4 | MDLb = 0.32 ug/L | 1 ug/L | |
| Molybdenum (Mo) | Dissolved | 2742 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.46 ug/L | 1 ug/L | |
| Nickel (Ni) | Total Recoverable | 2128 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 1.63 ug/L | 1 ug/L | 52 ug/L ^{6,9} |
| Nickel (Ni) | Dissolved | 2728 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.34 ug/L | 1 ug/L | 52 ug/L ^{6,9} |
| Nitrate + Nitrite as N | Total | 9555 | 30 | Lachat QuikChem Method No. 10-107-04-1-O | Aug 25, 2003 Nov 29, 2007 | MDLb = 0.01 mg/L | 0.03 mg/L | 1.0 mg/L |
| Nitrate + Nitrite as N | Dissolved | 9556 | 160 | Lachat QuikChem Method No. 10-107-04-1-O | Aug 25, 2003 Nov 29, 2007 | MDLb = 0.01 mg/L | 0.03 mg/L | 1.0 mg/L |
| Total Kjeldahl Nitrogen (TKN) | Dissolved | 9588 | 160 | Lachat QuikChem Method No. 10-107-06-5-J | Rev 2.0 | MDLb = 0.06 mg/L | 0.08 mg/L | |
| Total Kjeldahl Nitrogen (TKN) | Total | 9585 | 30 | Lachat QuikChem Method No. 10-107-06-5-J | Rev 2.0 | MDLb = 0.06 mg/L | 0.08 mg/L | |
| Nitrogen (Total) | Total | 9595 | 30 | Lachat 10-107-04-4-B | | MDLb = 0.04 mg/L | 0.05 mg/L | |
| Nitrogen (Total) | Dissolved | 9598 | 160 | Lachat 10-107-04-4-B | | MDLb = 0.04 mg/L | 0.05 mg/L | |
| Non Carbonate Hardness | Total | 9843 | 199 | calculated | | NA | NA | |
| Organic Carbon | Dissolved | 9727 | 9727 | SM 5310 C | 2011 | | 0.5 mg/L | |
| Organic Carbon | Total | 9725 | 9725 | SM 5310 C | 2011 | | 0.5 mg/L | |
| Percent Sodium | Total Recoverable | 9925 | 199 | calculated | | NA | NA | |
| pH | Total | 9305 | 199 | SM 4500 H ⁺ B | 2011 | NA | NA | 7.0 – 9.0 ³ |
| Phosphorus as P | Total | 9415 | 30 | Lachat 10-115-01-1-E | March, 2016 | MDLb = 0.01 mg/L | 0.02 mg/L | |

| Analyte | | | | Analytical Method | | Achievable Laboratory Limit | | Action Limit |
|----------------------------|-------------------|------------|--------------|-------------------|----------|-----------------------------|-----------------|--------------------------|
| Description | Sample Fraction | Lab Number | Group Number | Method | Revision | MDL ¹ | RL ² | |
| Potassium (K) | Total Recoverable | 1219 | 199 | EPA 200.7 | Rev 4.4 | MDLs = 0.282 mg/L | 1 mg/L | |
| Potassium (K) | Dissolved | 1819 | 173 | EPA 200.7 | Rev 4.4 | MDLs = 0.179 mg/L | 1 mg/L | |
| Residual Sodium Carbonate | Total | 9844 | | calculated | | NA | NA | |
| Selenium (Se) | Total Recoverable | 2134 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.58 ug/L | 1 ug/L | 5 ug/L ^{6,9} |
| Selenium (Se) | Dissolved | 2734 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.48 ug/L | 1 ug/L | 5 ug/L ^{6,9} |
| Silica (SiO ₂) | Total Recoverable | 1214 | 199 | EPA 200.7 | Rev 4.4 | MDLb = 0.13 mg/L | 2 mg/L | |
| Silica (SiO ₂) | Dissolved | 1814 | 173 | EPA 200.7 | Rev 4.4 | MDLb = 0.093 mg/L | 2 mg/L | |
| Silver (Ag) | Total Recoverable | 2147 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.27 ug/L | 1 ug/L | 3.8 ug/L ^{6,8} |
| Silver (Ag) | Dissolved | 2747 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.29 ug/L | 1 ug/L | 3.8 ug/L ^{6,8} |
| Sodium (Na) | Total Recoverable | 1211 | 199 | EPA 200.7 | Rev 4.4 | MDLb = 2.61 mg/L | 3 mg/L | a ³ |
| Sodium (Na) | Dissolved | 1811 | 173 | EPA 200.7 | Rev 4.4 | MDLb = 0.901 mg/L | 3 mg/L | a ³ |
| Sodium Adsorption Ratio | Total Recoverable | 9930 | 199 | calculated | | NA | NA | |
| Sulfate as SO ₄ | Dissolved | 9440 | 199 | EPA 300.0 | Rev 2.0 | MDLb = 0.21 mg/L | 1 mg/L | 250 mg/L ^{3,5} |
| Suspended Solids | Total | 9850 | 118 | USGS I-3765-85 | 1985 | | 5 mg/L | |
| Thallium (Tl) | Total Recoverable | 2181 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 0.43 ug/L | 1 ug/L | 0.24 ug/L ^{3,7} |

| Analyte | | | | Analytical Method | | Achievable Laboratory Limit | | Action Limit |
|---------------|-------------------|------------|--------------|-------------------|----------|-----------------------------|-----------------|---------------------------|
| Description | Sample Fraction | Lab Number | Group Number | Method | Revision | MDL ¹ | RL ² | |
| Thallium (Tl) | Dissolved | 2781 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.33 ug/L | 1 ug/L | 0.24 ug/L ^{3,7} |
| Zinc (Zn) | Total Recoverable | 2130 | 7 | EPA 200.8 | Rev 5.4 | MDLb = 4.20 ug/L | 1 ug/L | 120 ug/L ^{6,8,9} |
| Zinc (Zn) | Dissolved | 2730 | 144 | EPA 200.8 | Rev 5.4 | MDLb = 0.52 ug/L | 1 ug/L | 120 ug/L ^{6,8,9} |

¹ **Method Detection Limit:** calculated limits from 2018/2019. MDLb is calculated/obtained from analyzed laboratory reagent blanks. MDLs is calculated from analyzed laboratory fortified blanks.

² **Reporting Limit**

³Based on criteria for Class I streams

⁴Based on 1-day arithmetic average

⁵Based on 30-day arithmetic average

⁶This is a hardness-dependent criteria (value given based on hardness of 100 mg/L)

⁷Based on human health criteria

⁸Based on acute aquatic life criteria

⁹Based on chronic aquatic life criteria

¹⁰Based on a pH of 9, temperature of 30, and where salmonids are present

a – 50 percent of total cations as milliequivalents per liter

* based on distilled matrix

Appendix B

**Laboratory Method and Performance Criteria for E. coli Bacteria Analyzed
by the North Dakota Department of Environmental Quality Division of
Microbiology**

| Analyte Description | Analyte Number | Analytical Method | Achievable Laboratory Limits ¹ ((Counts/100 | | Action Limit (#/100/mL) |
|---------------------|----------------|---|--|----------------------------------|-------------------------|
| | | | Lower Detection Limit (#/100 mL) | Upper Detection Limit (#/100 mL) | |
| E. Coli bacteria | 33130 | Colilert Quantitray Enumeration APHA Method 9223-B | 10 | 24,000 ⁰ | 10 |

¹ Expressed as Most Probable Number (MPN)

Appendix C
Sample Identification/Custody Forms Used by the
Watershed Management Program

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